



Tools and Apps to Enhance Situational Awareness for Global Disease Surveillance

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August 21st, 2014

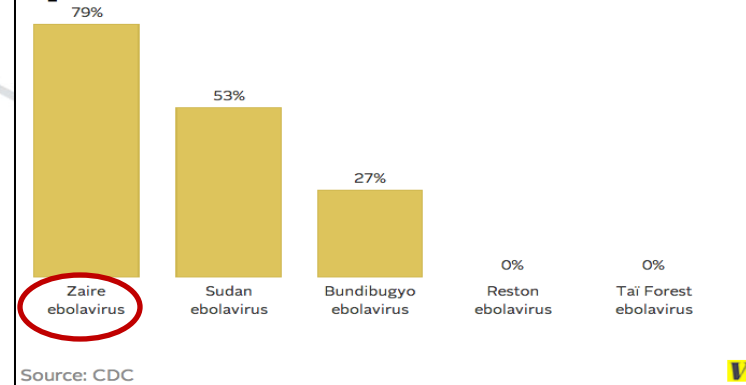


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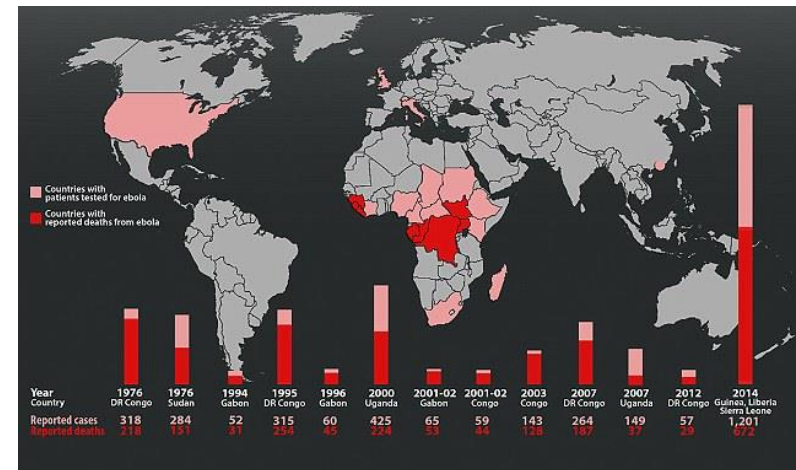
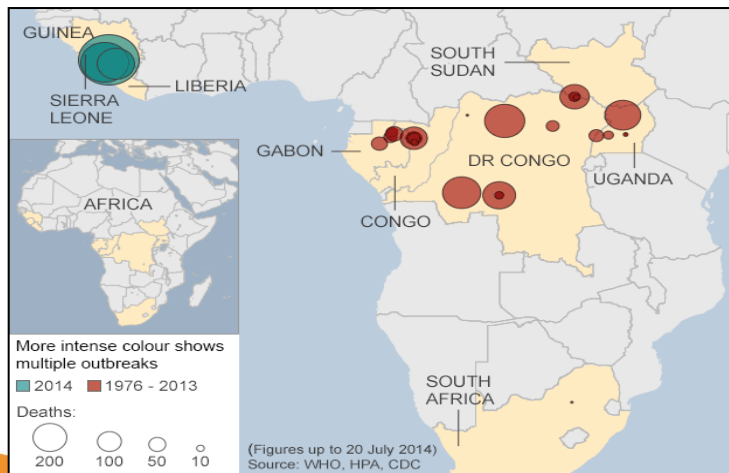
Operated by Los Alamos National Security, LLC for the U.S. Department of Energy's NNSA



Death rates of the 5 Ebola virus species



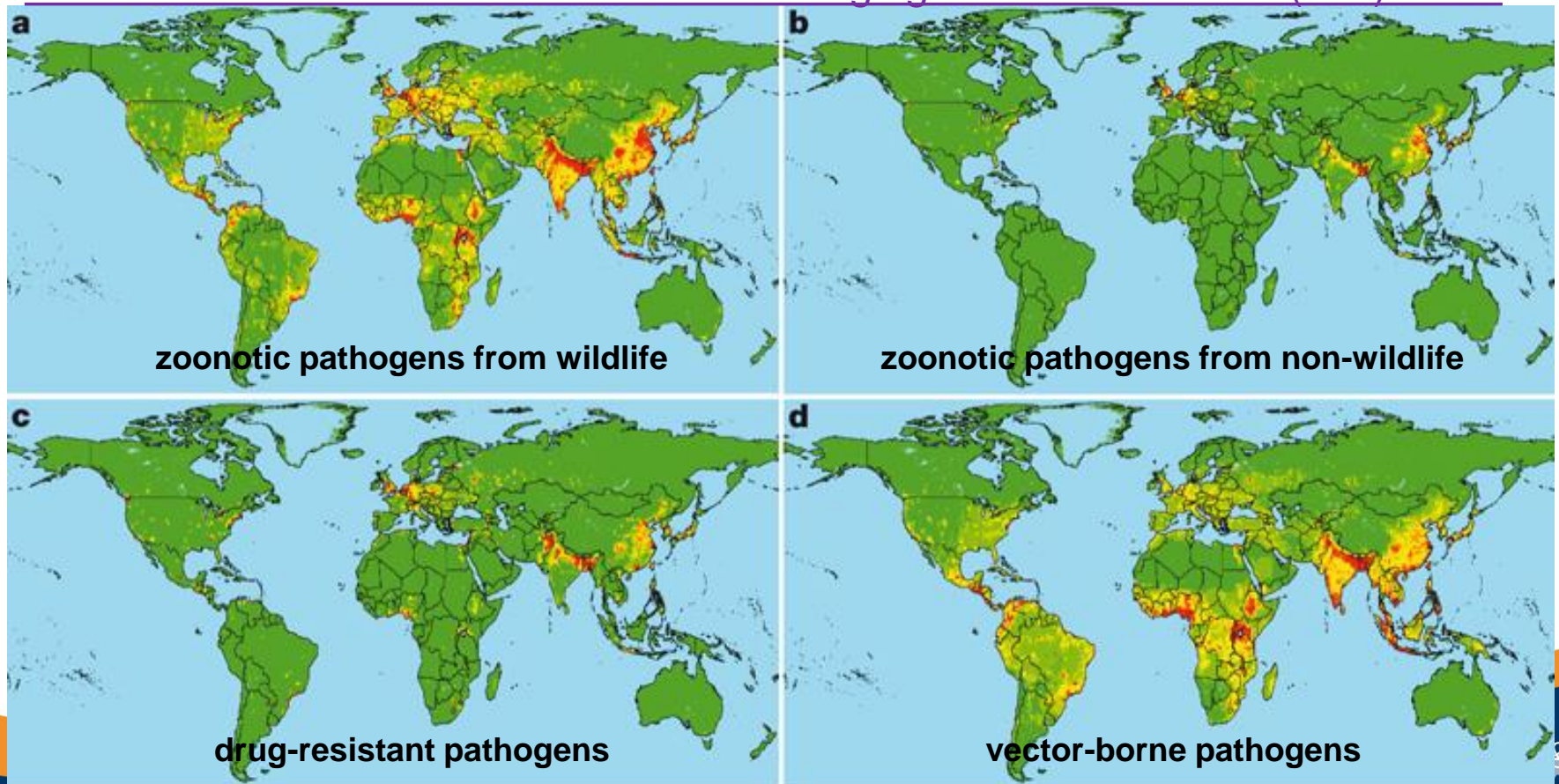
Situational awareness - The **perception** of elements in the environment within a given time and space, the **comprehension** of their meaning, and the **projection** of their status in the near future (Endsley, 1995)



Situational awareness in infectious disease surveillance

Important for both early warning and early detection of a disease outbreak (naturally or intentionally caused)

Global distribution of relative risk of an emerging infectious disease (EID) event



Situational awareness in infectious disease surveillance

- Occurs through different means and at different levels (local, global)



- Tools needed to transform data into information

Situational awareness in infectious disease surveillance – LANL tools

- A suite of tools being developed to provide actionable information and knowledge for enhanced situational awareness during an unfolding event



A tool to validate/confirm disease surveillance information. Contains information on disease surveillance resources worldwide



A tool to rapidly select appropriate epidemiological models for infectious disease prediction, forecasting and monitoring



An app to provide context and a frame of reference for disease surveillance information through matching of user input to library of global historical disease outbreaks

The biosurveillance resource directory

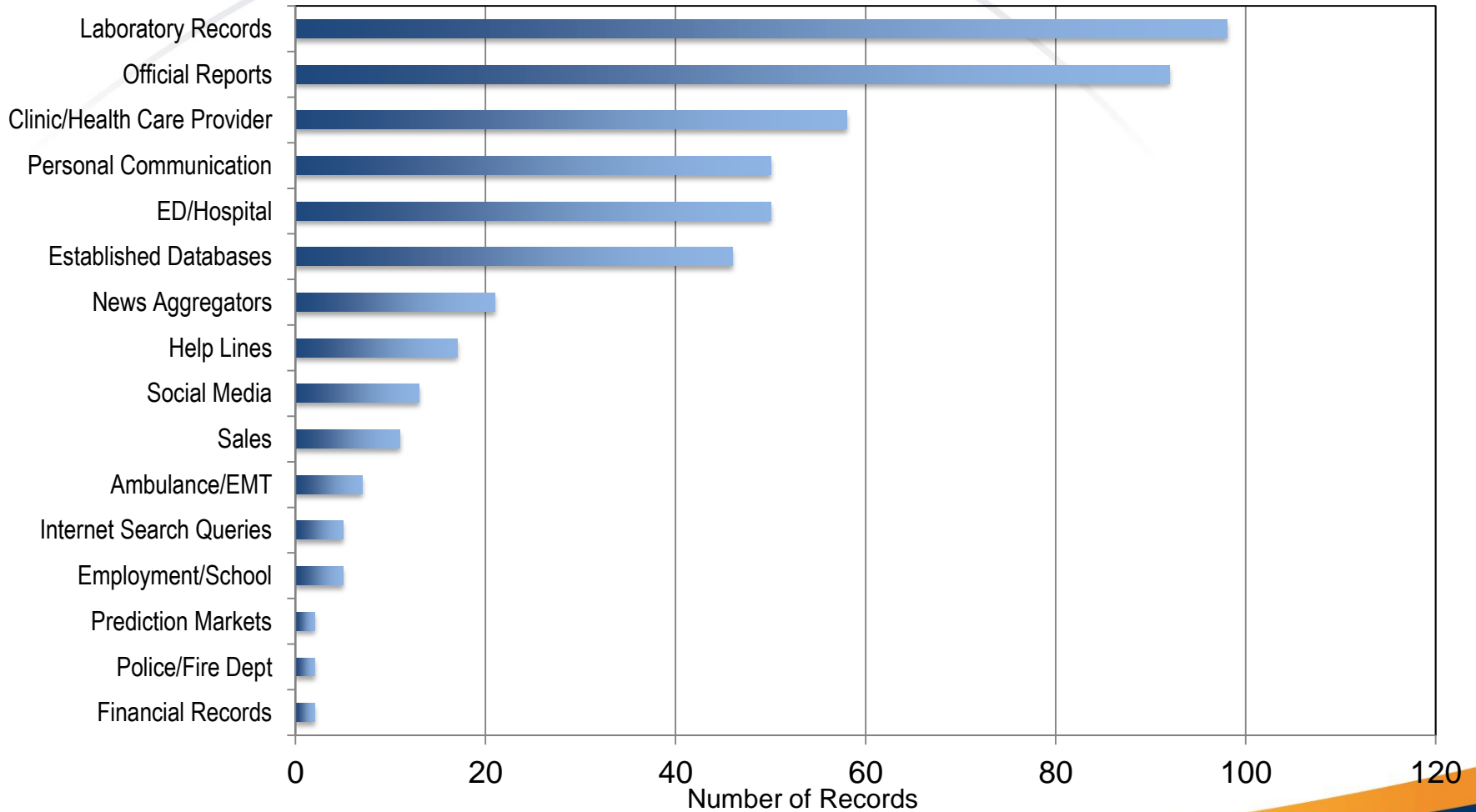
- Relational database containing biosurveillance products and tools available worldwide (>350 records to date)
- Hosted through LANL research library (brd.lanl.gov)
- Based on framework that classifies and characterizes biosurveillance resources
- Searchable by multiple keywords (data streams, geographic location, disease, etc.)
- Provides access to resource website
- **Does not** house data per se, facilitates discovery and obtaining the right resources and data
- Anticipated users - analysts, public health officers, decision makers, national and local crisis planners and responders (military and civilian)



BRD categories

System Category	Examples
<p>Supersystem</p> <p>A system that collects information from multiple data streams and other surveillance systems, and analyzes the data that is collected to inform the biosurveillance goal</p>	<p>GOARN TESSy SAGES</p>
<p>System</p> <p>A system that collects information from one or more data streams and analyzes the data that is collected to inform the biosurveillance goal</p>	<p>Biosentinel ASPREN ProMed Health Map</p>
<p>Data Source</p> <p>A system that collects information from one or more data streams but does not analyze the data collected for a biosurveillance goal</p>	<p>Google News Gene Expression Omnibus Crisis Mappers</p>
<p>Tool / Software</p> <p>Software or application that enables the collection or analysis of data</p>	<p>Essence EARS First Watch</p>
<p>Collective</p> <p>A group of individuals or organizations with the shared objective of contributing to data collection and analysis to inform a biosurveillance goal</p>	<p>Mekong Basin Disease Surveillance Wildlife Data Integration Network</p>

Data stream categories used in active cataloged surveillance systems



biosurveillance resource directory

Basic Search | **Fielded Search**

Tools

My marked records:
Export marked records
Search History:

[\[-\] Tools](#)
[Browse Resources](#)

[\[-\] About](#)
[Help](#)
[What's new](#)
[Contact us](#)

Select field to search and enter search terms:

Disease	<input type="text" value="cholera"/>	AND
Resource	<input type="text" value="system"/>	AND
-- All Fields --	<input type="text"/>	Add Search Box

Phrase search (enclose in quotation marks): "infectious diseases"

Word search: infectious diseases

[More search tips](#)

Go

**fielded search and
browse function**

Limit results:

☐ New records only

Year First In Service:

TO e.g., 2002 TO 2007

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Outside | Copyright 2013-14 Los Alamos National Security, LLC All rights reserved | [Privacy](#)

 Research Library

[-] Category

System (7)
Collective (1)

[-] Status

Active (7)
Inactive (1)

[-] Datastream

Official Records (5)
Laboratory Records (4)
ED/Hospital Records (3)
Clinic/Health Care Providers (2)
Employment/School Records (2)
Established Databases (1)
Personal Communication (1)
Sales (1)

[-] Accessibility

Limited (8)

[-] Primary Sponsor

[-] Disease Category

Diseases of Organizational Importance (5)
Transmission (5)
Population (4)
Syndrome (4)
Environment (2)
Diseases of Emerging Importance (1)
Vector (1)

[-] Population Domain

Human (4)

Results for: (disease:(cholera) AND resource:(system))

8 records sorted by relevance | year

Results per page 25 ▼

Mark or Clear all on page

Mark records to export

Page 1 of 1



Resource Website

Reports Website

☐ 1. Cholera and Other Vibrio Illness Surveillance System

Centers for Disease Control and Prevention
1988

☐ 2. Electronic Foodborne Outbreak Reporting System

Centers for Disease Control and Prevention
1998

Resource Website

Reports Website

☐ 3. National Outbreak Reporting System

Environmental Protection Agency ; Council of State and Territorial Epidemiologists ;
Centers for Disease Control and Prevention
2009

Resource Website

Reports Website

☐ 4. State Electronic Notifiable Disease Surveillance System

Georgia Department of Public Health
2009

Resource Website

Reports Website

☐ 5. Quarantine Activity Reporting System

Centers for Disease Control and Prevention
2005

Resource Website

☐ 6. Syndrome Tracking and Encounter Management System

New Hampshire Department of Health and Human Services
20uu

Resource Website

☐ 7. Wisconsin Electronic Disease Surveillance System

Wisconsin Department of Health Services
20uu

Resource Website
Reports Website

Hyperlinks to
resource websites,
contacts and
associated
documents



Cholera and Other Vibrio Illness Surveillance System

Acronym: COVIS

Category: System

Status: Active

Scope: The COVIS system is a national database of reported human illnesses caused by all Vibrio species. COVIS was initiated by CDC, FDA, and the Gulf Coast states (Alabama, Florida, Louisiana, Mississippi, and Texas) in 1988. CDC has maintained a database of Vibrio infections from humans in order to obtain reliable information on illnesses associated with Vibrio species.

Sponsor(s): Centers for Disease Control and Prevention (CDC)

Primary Sponsor Type: Government

Population Domain: Human

Disease Category: Transmission ; Syndrome ; Transmission ; Diseases of Organizational Importance

Disease (Human): Cholera ; Vibrio, non cholera

Geographical Domain: United States

Geocoverage (States): All States and Territories

Contact: CDC ; Atlanta ; Georgia ; United States of America ; 30329-4018 ; 404.718.4560 ; bwk9@cdc.gov ; Contact : Ezra Barzilay ; MEDICAL EPIDEMIOLOGIST ; Contact Website : www.cdc.gov

Contact: CDC ; Atlanta ; Georgia ; United States of America ; 30329-4018 ; 404.639.2839 ; ivz9@cdc.gov ; Contact : Anna Newton ; GUEST RESEARCHER/AREF ; Contact Website : www.cdc.gov

System Domain: Human

Date First in Service: 1988

Update Frequency: Yearly

Accessibility: Limited

DataStream

Category	Sub Category	Population	Type	Collection method	Notes
Laboratory Records	Laboratory Results	Human	Diagnostic	Email	
Official Records	Government	Human	Syndromic	Email	

Database: BRD

data streams
used by
resource



Motivation for BARD development

Epidemiological models have utility in disease surveillance, however, choice of an appropriate model is difficult without information about;

- Scope of their use (e.g. operational status of such models, their purpose, input data needs, time to results, etc.)
- Features - the diversity of model types and the manner in which they are described (risk mapping, disease dynamics, statistical, anomaly detection, network, etc.)

The biosurveillance analytics resource directory

- Prototype - 75 models covering Malaria, Cholera, Influenza, Foot and Mouth disease, Dengue
- Provides specific information about an operational model that has been systematically categorized and highlighted
- Allows “apples to apples” comparison of multiple models if available for a single disease
- Provides links to specific models and updated and accurate contact information for a model facilitating its immediate use
- Is a model characterization tool - The framework could be applicable to any new models that may be included in the future and common characteristics and attributes of models would be cataloged



Overview Disease Location Conceptual Model Tools Inputs / Outputs Data Utility Docs Notes Framework

ID MOD0040 **Disease** Flu

Name Framework for Reconstructing Epidemiological Dynamics

Acronym FRED **Creation Date** 2009

Overview FRED (Framework for Reconstructing Epidemiological Dynamics) is an open source modeling system developed by the University of Pittsburgh Public Health Dynamics Laboratory. The system uses agent-based modeling based on census-based synthetic populations that capture the demographic and geographic distributions of the population, as well as detailed household, school, and workplace social networks. FRED supports research on the dynamics of infectious disease epidemics and the

Purpose Forecasting **Question Category**

Model Question Can be configured to multiple types of questions: supports research on the dynamics of infectious disease, epidemics, and the interacting effects of mitigation strategies, viral evolution, and

Scope Platform

Main Conceptual Model Type Disease Dynamics **Based on Model Resource**

Primary Organization University of Pittsburgh

Contacts University of Pittsburgh

Select Contact John Grefenstette
gref@pitt.edu
412-648-9920

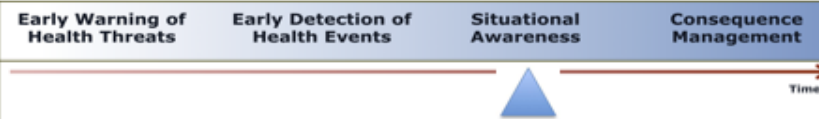
Go to Contact **New Contact**

Sponsoring Agency(s) **Primary Developer** Academic

Select Agency NIH National Institutes of Health
Role **Notes**
Through MIDAS
Funding support

Go to Agency **New Agency**

Biosurveillance Goal



☐ Baseline Awareness

Model Utility



Readiness Configurable Generic Framework

FRED is available through open source in the hopes of making large-scale agent-based epidemic models more useful to the policy-making community, the research community, and as a teaching tool for students in public health.

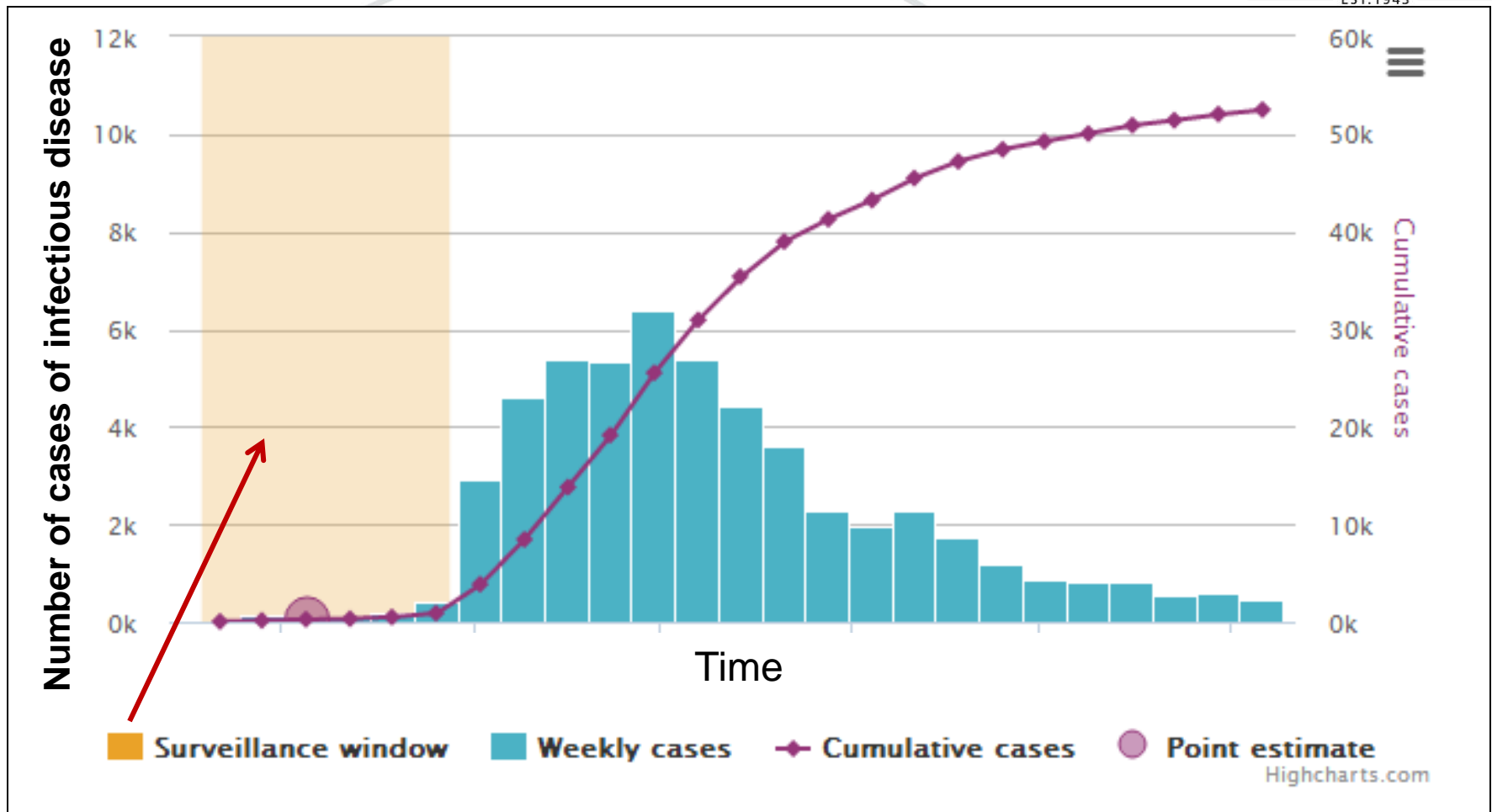
Websites/URLs

<https://midas.pitt.edu/index.php?ref=www.pitt.edu/~midas/edid-812-708&id=70>

Open in Browser

Open in Browser

The surveillance window concept



The duration of time within which information obtained can be used for early warning or early detection of a disease outbreak

The surveillance window app

- Cross platform app based on the surveillance window concept
- Contextualizes incoming information during an infectious disease outbreak, supports decision making
- Places a frame of reference for where a case count is during an outbreak
- Determines whether the unfolding events are still within a surveillance window, and therefore feasible to control
- Suggests additional information sources that could support effective consequence management of an outbreak
- Increases the granularity of situational awareness



The surveillance window app - SWAP

Surveillance Window App Terminology Data Streams About

Select a disease.

----- ▾

Surveillance Window App Terminology Data Streams About

Disease Foot And Mouth Disease ▾

Location ----- ▾ **Map**

Animal identifier ----- ▾

Number of infected premises

Case count interval ☐ Weekly ☐ Total

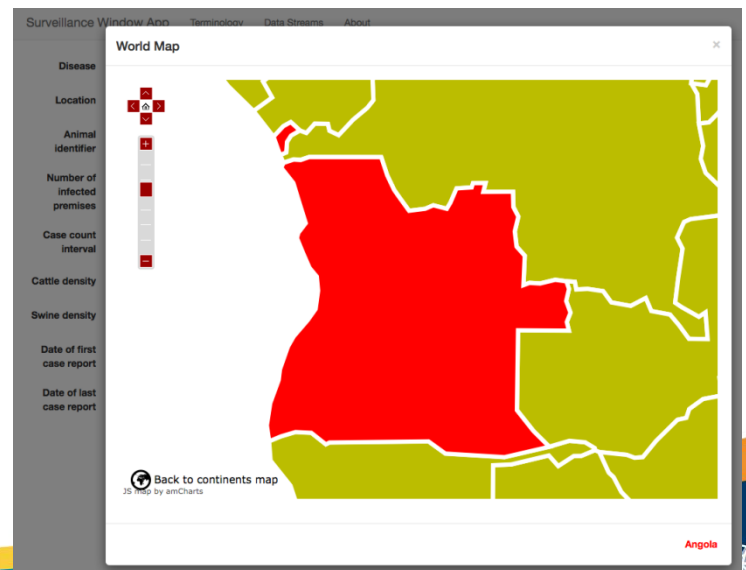
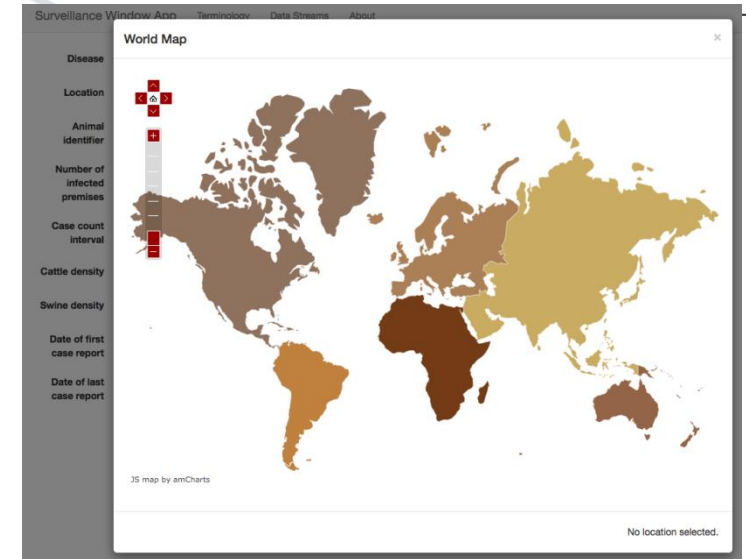
Cattle density ----- ▾

Swine density ----- ▾

Date of first case report

Date of last case report

Clear Search



Disease

Location

Disease status

Population at risk

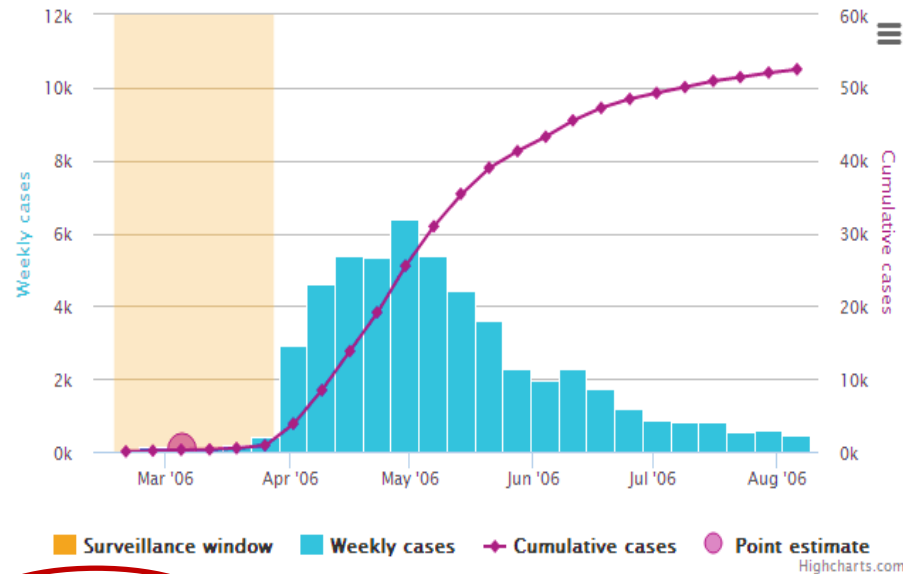
Cases

First case report

Last case report

Sort by

96% | Cholera in Angola (2006)



Outbreak factors

- The outbreak affected the entire country
- Many cases occurred in Luanda, where the population was concentrated in the capital
- The area was without sufficient quantities of water, proper drainage and rubbish collection
- This was the first outbreak in Angola in 9 years

96% | Angola - 2006

73% | South Africa - 2000

69% | Democratic Republic of the Congo - 2011

68% | Republic of Congo - 2006

65% | Laos - 2007

64% | Cameroon - 2011

62% | Zambia - 2003

61% | Nigeria - 2010

59% | India - 2007

57% | Niger - 2012

57% | Cameroon - 2010

54% | Zambia - 2008

User input

SWAP output – display of closest matching historical outbreak with point estimate for user input

SWAP output - Similarity scores for outbreaks in SWAP library

References

- Global Task Force on Cholera Control. (2013). Cholera Country Profile: Angola. World Health Organization. Retrieved June 27, 2013 [\[LINK\]](#)

Suggested data streams

Inside surveillance window

Laboratory records

ED/Hospital records

Clinic/health care provider records

Outside surveillance window

News aggregators

Official reports

Social media

Scores

Factor	Score	Weight	Weighted score
Case count	100	0.300	30
Time	100	0.300	30
Population at risk	80.5	0.200	16.1
Disease status	100	0.130	13
Location	100	0.070	7
Total			96.1

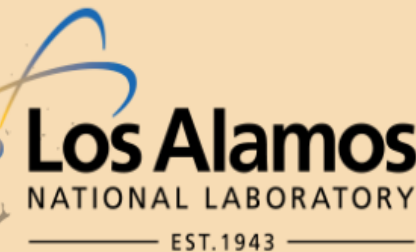
LANL decision support tools - the challenges

- Sustainability of tools and resources
 - Updated and expanded content – automated data mining tools
 - Curated content – interactive content management, engaging all stakeholders
 - Maintaining utility - outreach and tool refinement



LANL BSV Gateway

- Knowing the resources available
- Matching resources to need
- Identifying gaps in resources
- Developing support tools
- Building collaborations
- Fostering innovation



ENHANCING SITUATIONAL AWARENESS FOR INFECTIOUS DISEASE SURVEILLANCE



Surveillance Window App (SWAP)

An app to provide context and a frame of reference for disease surveillance information.



Biosurveillance Resource Directory (BRD)

A tool to validate/confirm disease surveillance information.



Biosurveillance Analytics Resource Directory (BARD)

A tool to rapidly select appropriate epidemiological models.

- Decision support tools will be offered through LANL's Biosurveillance (BSV) gateway (bsv.lanl.gov) coming soon

- Knowing the resources available
- Matching resources to need
- Identifying gaps in resources
- Developing support tools
- Building collaborations
- Fostering innovation



Surveillance Window App (SWAP) An app to provide context and a frame of reference for disease surveillance information.



Biosurveillance Resource Directory (BRD) A tool to validate/confirm disease surveillance information.



Biosurveillance Analytics Resource Directory (BARD) A tool to rapidly select appropriate epidemiological models.

What's happening?

Timeline @Mentions Retweets Searches Lists



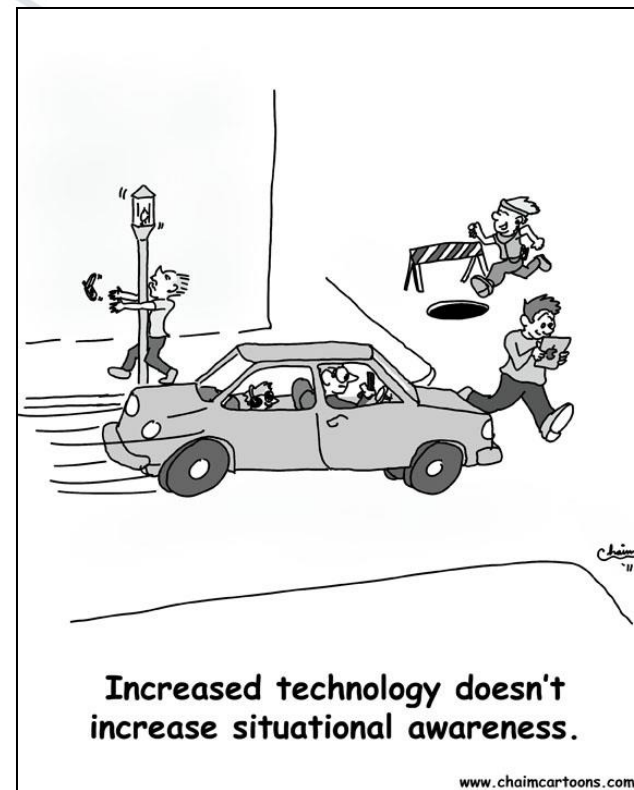
blechleypark Kelsey Griffin
Prof Jack Copeland: "A list of the most important names of WWII would have Churchill at the top and #Turing not far behind" #bpark
18 minutes ago



newsyc50 Hacker News 50
Hackers to follow on G+? <http://news.ycombinator.com/item?id=2737152>
19 minutes ago

Take home message

- LANL is developing new decision support tools for infectious disease surveillance - **focus on information analysis and integration**
- Tools will be accessible to global disease surveillance community through the LANL BSV gateway

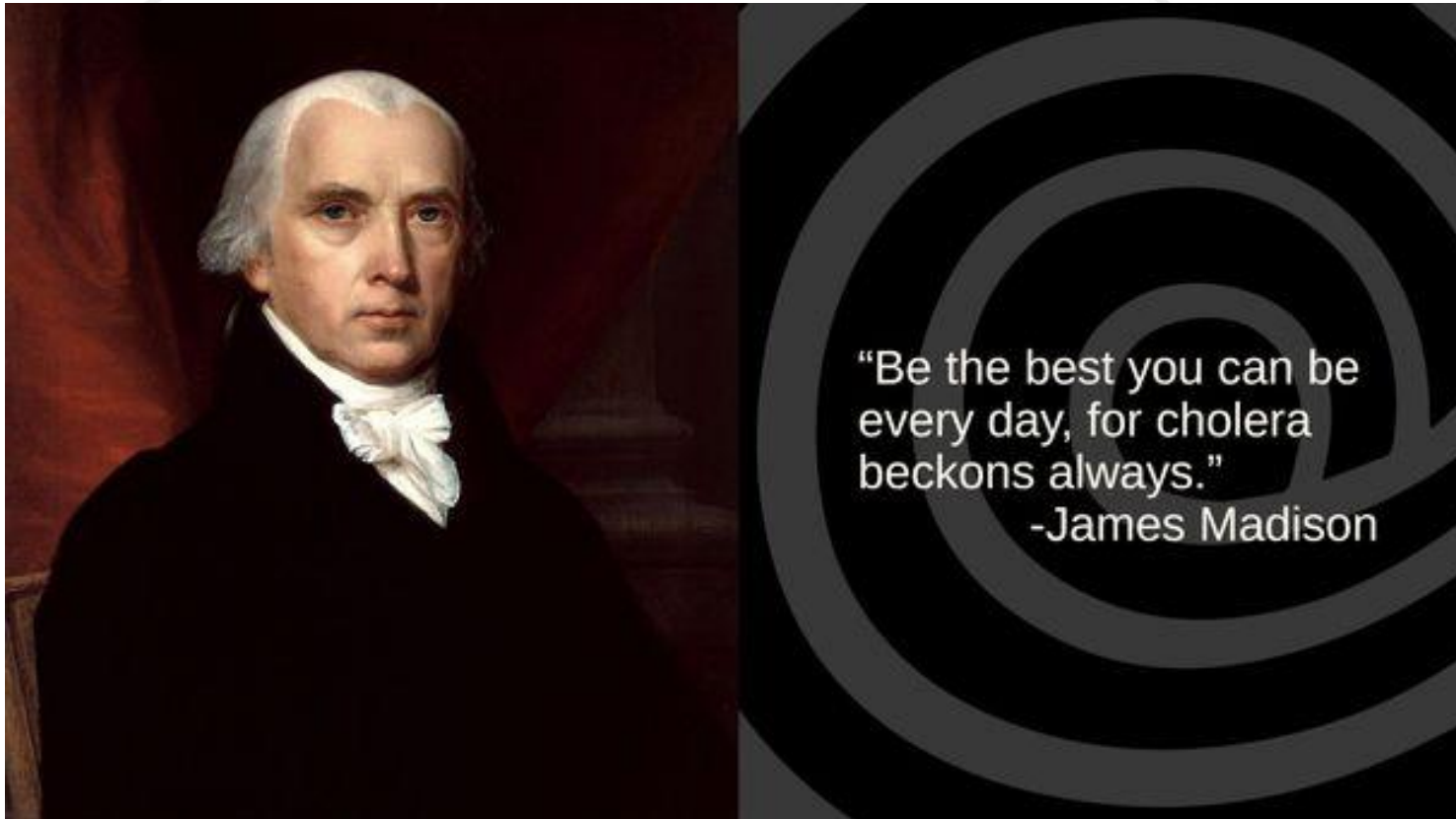


LANL team

- Mr. Esteban Abeyta
- Ms. Lauren Castro
- Ms. Ashlynn Daughton
- Mr. Eric Generous
- Mr. Geoffrey Fairchild
- Dr. Kristen Margevicius
- Dr. Reid Priedhorsky
- Dr. Kirsten Taylor-McCabe
- Dr. Alina Deshpande



Thank you!



Extra Slides

Biosurveillance



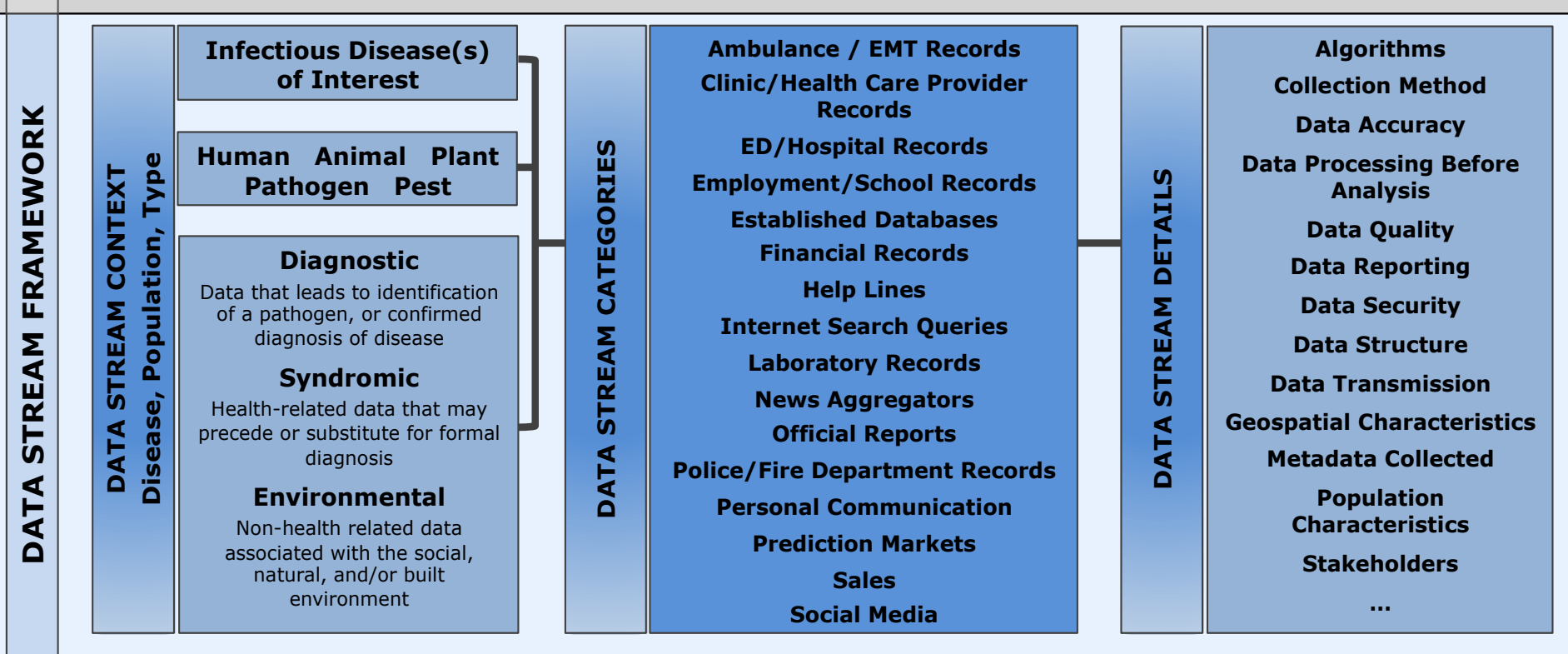
Process: *The process of gathering, integrating, interpreting, and communicating*

Knowledge: *Essential information related to all-hazards threats or disease activity affecting human, animal, or plant health*

Purpose: *To achieve early detection and warning, contribute to overall situational awareness of the health aspects of an incident, and to enable better decision making at all levels*

National Strategy for Biosurveillance, 2012

GOALS	Early Warning of Health Threats	Early Detection of Health Events	Situational Awareness	Consequence Management
	Surveillance that enables the identification of potential threats, including emerging and re-emerging diseases, that may be undefined or unexpected	Surveillance that enables identification of disease outbreaks (either natural or intentional in origin), or events that have occurred, before they become significant	Surveillance that monitors the location, magnitude and spread of an outbreak or event once it has occurred	Surveillance that assesses impacts and informs response to an outbreak or an event
Time				
Baseline Awareness				
Information that can inform and facilitate the achievement of the above surveillance goals and can be related to population demographics and health, the natural, social, and built environment and underlying disease patterns and characteristics				



DISEASE MODELING FOR BIOSURVEILLANCE

Purpose

Monitoring	<i>Capability to assess the current disease situation</i>
Prediction	<i>The probability determination that a disease outbreak will occur at a given time or location</i>
Detection	<i>Capability to discern the occurrence of a disease outbreak</i>
Forecasting	<i>The probability determination of the extent, duration, and/or magnitude of a disease outbreak</i>
Assessment	<i>Evaluation or estimation of consequences, scenario appraisal</i>

Figure 1.

Model Objective

Model Scope

BSV Goals

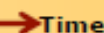
Early Warning of Health Threats

Early Detection of Health Events

Situational Awareness

Consequence Management

Baseline Awareness



Conceptual Model

Disease Models

Risk Mapping

Risk factor analysis displayed spatially or spatio-temporally

Anomaly Detection

Alerts over thresholds: Finding patterns in data that do not conform to expected behavior

Disease Dynamics

Progress and/or behavior of disease within a host or population

Disease Transmission Model (States/Compartments)

Equation-Based

Simulation

Network Structure

Auxillary Models: *Economic, Financial, Risk Analysis, CBA, Airborne transmission, ...*

Model Tools : Computational, Machine learning, Regression, Statistical ...

Tool Purpose: Model Fit, Model Validation, Parameter Estimation, Time series Analysis, Threshold Detection ...

Model Inputs

Host Population, Disease, Vector/Reservoir
Environment (natural, social, built), Control Efforts

Model Outputs

Model Assembly: *single, multiple, complex, modular, hybrid,...*

Assumptions and Limitations

Model Utility

Data

Data sources required
Availability of data sets
Data is spatially referenced
Accuracy and completeness of data
Documentation

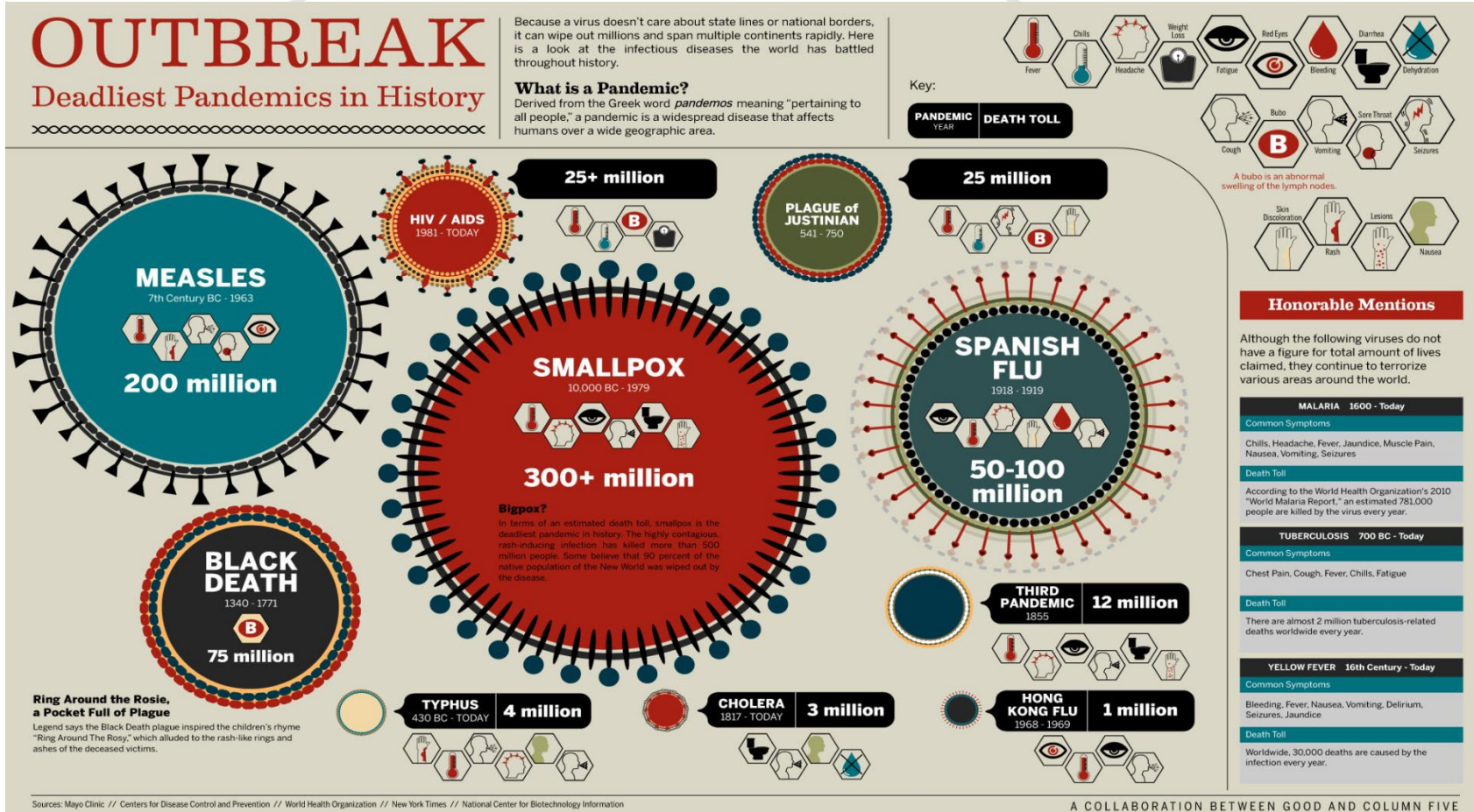
Verification Validation

Model verification
Model validated for purpose built
Sensitivity analysis of parameters
Uncertainty (input, output)
Comparison with other models
Comparison with real system
Model independently tested
Documentation

Operations

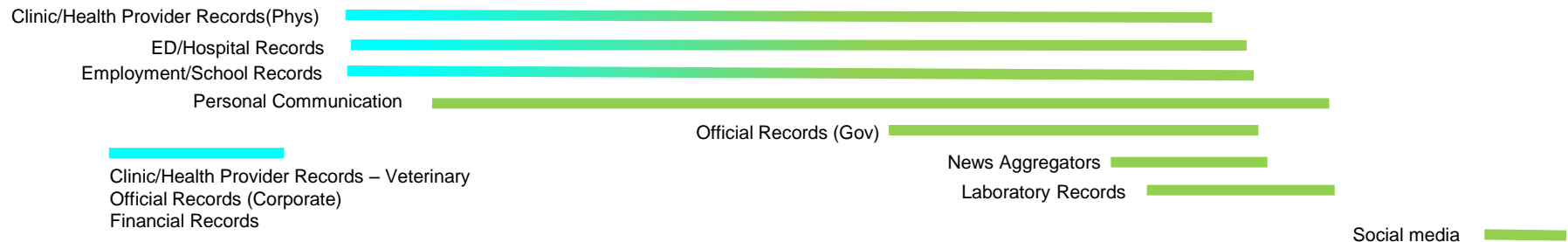
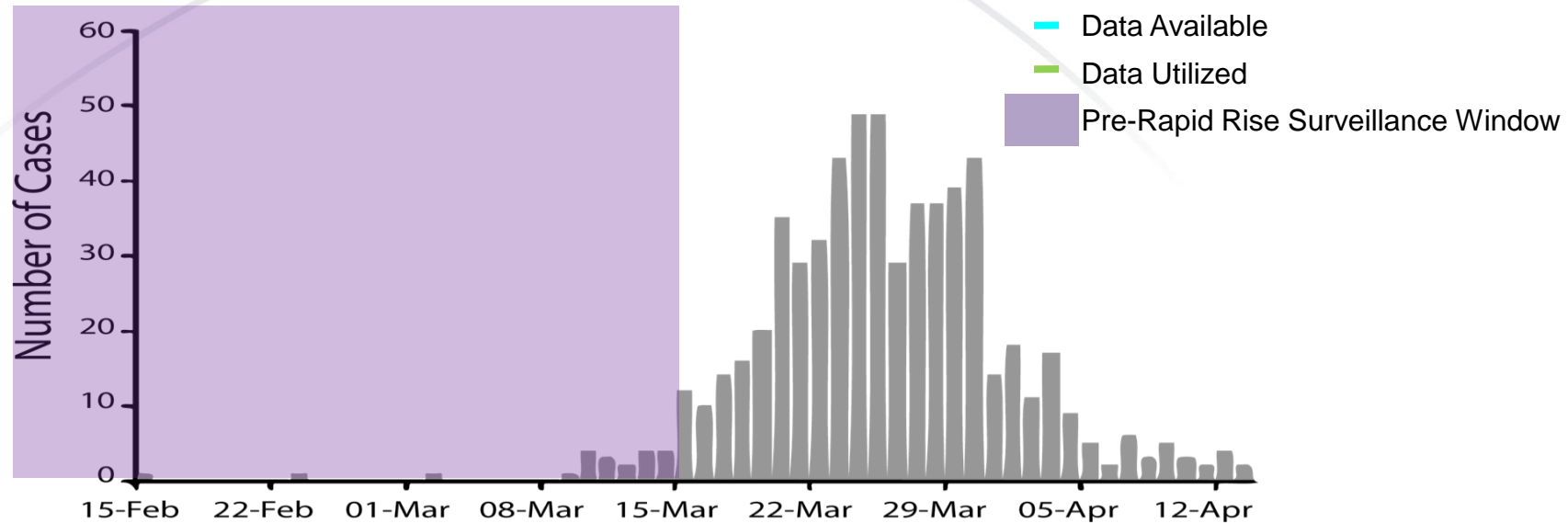
Model and developer team accessibility
Funding support
Model used for decision support
Extensibility, model adaptation time
Source code / software availability
Hardware platform, OS
Computational time
Cost to implement, documentation

Situational awareness in infectious disease surveillance – pandemic potential



The surveillance window concept

Influenza: La Gloria, Mexico, 2009 Data available vs utilized



Not Available:

Internet Search Queries, Sales, Help Lines, Ambulance Records, Prediction Markets, Established Databases, Police Records/Fire Department Records